Am J Cardiovasc Dis 2024;14(6):355-367
www.AJCD.us /ISSN:2160-200X/AJCD0159635

*Original Article*

# Burden and predictors of mortality related to cardiogenic shock in the South Bronx Population

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Received August 5, 2024; Accepted October 30, 2024; Epub December 15, 2024; Published December 30, 2024

**Abstract:** Objectives: Cardiogenic shock is a significant economic burden on healthcare facilities and patients. The prevalence and outcome of cardiogenic shock in the South Bronx are unknown. The aim of the study was to examine the burden of non-AMI CS in Hispanic and Black population in South Bronx and characterize their in-hospital outcomes. Methods: We reviewed patient charts between 1/1/2022 and 1/1/2023 to identify patients with a primary diagnosis of cardiogenic shock (ICD codes R57.0, R57, R57.8, R57.9) residing in the following zip codes: 10451-59 and 10463. Student's T-test was used to assess differences for continuous variables; chi-square statistic was used for categorical variables. A logistic regression analysis model was used to assess independent predictors of mortality. A *P*-value of < 0.05 was considered significant. Results: 87 patients were admitted with cardiogenic shock (60% African American, 67% male, mean age =62±15 years) of which 54 patients (62%) died. Those who died were older, had > 1 pressor, out-of-hospital arrest, arrested within 24 hours of admission, and had higher SCAI class, lactate, and ALT levels than those who were discharged. The logistic regression analysis model showed that older age ((RR=3.4 [95% CI: 3.3-3.45]), > 1 pressor (RR=3.4 [95% CI: 2.6-4.2]) and higher SCAI class (2.1 [95% CI: 1.5-2.1], all P < 0.05)) were independent predictors of mortality in patients with cardiogenic shock. Additionally, most of the patients had either Medicare or Medicaid insurance in predominantly African American study population. Conclusions: Cardiogenic shock carries a significant risk of death. Factors such as advanced age, the administration of more than one vasopressor, and a higher SCAI classification have been identified as independent predictors of mortality among inpatients with cardiogenic shock. Additionally, the progression and outcomes of the condition are influenced by variables like race (e.g., African American individuals in this study) and economic challenges, including the type of insurance coverage (e.g., Medicaid or Medicare). Further research is essential to explore strategies that could enhance survival rates in cardiogenic shock patients, with a particular focus on addressing economic and racial disparities.

**Keywords:** Cardiogenic shock, outcomes, mortality, diagnosis, treatment

## Introduction

Cardiogenic shock (CS) is a critical condition characterized by a significant reduction in cardiac output, leading to inadequate blood flow to vital organs. CS is experienced by approximately 5% to 7% of patients who present with acute myocardial infarction (AMI) [1]. It is more frequently seen in patients with ST-segment-elevation MI (STEMI) compared to those with non-STEMI [1]. Despite advancements in care, the acute mortality rate remains unacceptably high, around 60% [2-4]. However, recent years have seen a decline in mortality rates for AMI-CS. This has been attributed to the establishment of care goals, the introduction of quantitative diagnostic tools, and the rapid initiation of mechanical circulatory support (MCS) [5]. In this regard, diagnostic tools are focused on heart failure with respect to acute myocardial infarction. CS can be categorized based on which ventricle is affected. Left ventricle-dominant CS is characterized by high pulmonary capillary wedge pressure (PCWP) over 18 mmHg and normal or low central venous pressure (CVP) under 14 mmHg, due to reduced left ventricular (LV) contractility. Right ventricle-dominant CS is marked by elevated CVP over 14

https://doi.org/10.62347/HYCA6457

mmHg, with normal or low pulmonary artery pressure and PCWP under 18 mmHg, while maintaining normal LV function. Biventricular failure is identified by high CVP over 14 mmHg, normal or high PCWP over 18 mmHg, hypotension, and reduced LV function [6]. For patients with predominant left ventricular (LV) failure, mechanical circulatory support (MCS) options include intra-aortic balloon counterpulsation (IABP), Impella devices (LP/CP/5.0/5.5), and the TandemHeart percutaneous LV assist device. Venoarterial extracorporeal membrane oxygenation (VA-ECMO) can also be used for systemic circulatory support, but it requires careful monitoring for LV distension and pulmonary edema. In such cases, additional LV decompression or venting may be necessary, which can be achieved using IABP, a left-sided Impella device, pulmonary artery cannulation, or surgical LV venting. For patients with predominant right ventricular (RV) failure, MCS options include the Impella RP pump and the TandemHeart ProtekDuo percutaneous RV assist device. Patients with biventricular failure may benefit from bilateral Impella pumps or VA-ECMO combined with an LV venting mechanism [7].

The incidence of hospitalizations secondary to CS has increased in the past years primarily due to increased awareness of the disease and increased prevalence of cardiovascular comorbidities [5, 8-11]. Despite these changes in the overall demographics of CS, there are some variations with respect to CS estimates. Women, Black men, and Hispanic men had higher in-hospital death rates than White men, with Hispanic women having the highest [12]. The most recent US census estimates for Bronx County reveal the total population to be about 1,379,946 as of July 2022, with predominantly Hispanic (19.1%) and Black individuals (14.4%) [13]. Considering this demographic, it is essential to determine the outcomes of a high-risk cohort. The aim of the study was to examine the burden of non-AMI CS in Hispanic and Black population in South Bronx and characterize their in-hospital outcomes.

## Materials and methods

### *Data collection*

A retrospective observational cohort study of patients admitted with cardiogenic shock over 1 year was performed. The inclusion criteria were based on the following: 1. International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) codes, and in-hospital admissions with ICD-10-CM codes R57.0, R57, R57.8, and R57.9. 2. Admission within the date range 1/1/2022 and 1/1/2023. 3. Patients with ages > 18 years. 4. Patients who were not pregnant. 5. Patients residing in zip codes of South and Central Bronx (10451-59 and 10463). 6. Patients who had other causes of cardiogenic shock apart from acute myocardial infarction.

Exclusion criteria were based on the following: 1. Patients under 18 years of age. 2. Patients who were pregnant. 3. Patients who had missing data with respect to variables for data inclusion. 4. Patients who did not have signs of tissue hypoperfusion and were therefore less likely to have cardiogenic shock. 5. Patients who presented with cardiogenic shock related to acute myocardial infarction.

The data was cross-checked for accuracy and consistency by two other team members. The team members were blinded to each others' decisions. Demographic characteristics, including age, gender, race, insurance, and housing zip codes, were collected. Cardiovascular outcomes, including biochemical and clinical parameters, were assessed at admission, shock onset, and discharge. The cardiovascular biochemical markers included lactate, troponin, proBNP, and platelet count. The clinical cardiovascular parameters included hypotension, mental status, acute kidney injury (AKI), intensive care unit (ICU) admissions and length of stay, stroke events, in-hospital cardiovascular procedures, and in-hospital mortality. Cardiogenic shock was classified using SCAI guidelines [14]. AKI was defined using KDIGO criteria [15] which is as follows: increase in serum creatinine by 0.3 mg/dL or more (26.5 μmol/L or more) within 48 hours, increase in serum creatinine to 1.5 times or more than the baseline of the prior 7 days and urine volume less than 0.5 mL/kg/h for at least 6 hours. Thrombocytopenia was defined as platelet count < 150,000 [16]. Transaminitis was defined as per age and gender-adjusted criteria [17]. Microsoft Excel was used for data entry.

### *Statistical analysis*

Continuous variables were expressed as mean ± SD, and categorical variables were expressed

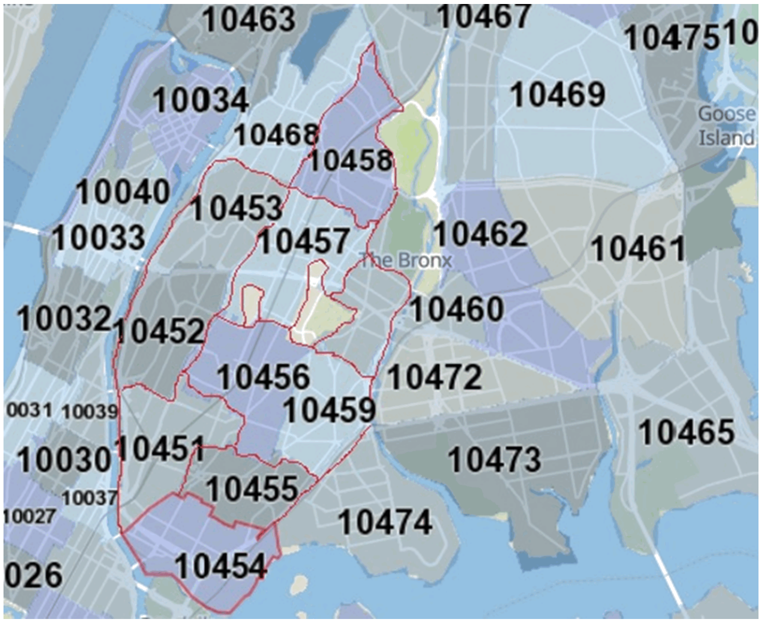


**Figure 1**. Geographical distribution of patient population (marked in red boundary) (image source: Vikram Itare).

as percentages. Categorical variables were compared using the chi-square test and Fischer test as appropriate. Student t-tests or Mann-Whitney U tests were used to compare continuous variables. The data was stratified for the African American population and discharge disposition. Continuous variables in both strata were compared using an independent t-test. Univariate and multivariate logistic regression analyses were used to determine the association between patient characteristics and in-hospital mortality, ER admissions, ICU admissions, AKI during hospital stay, need for vasopressor support, type of vasopressor used, and discharge disposition.

Variables with a $P < 0.2$ in univariable analysis were eligible to enter the multivariable model. The associations were expressed as odds ratios (ORs) with 95% confidence intervals (CIs). A $P < 0.05$ was considered statistically significant. Statistical analyses were performed with SPSS version 22.0 (IBM Corp., Armonk, New York, USA) and R software.

## Results

*Demographic characteristics*

87 patients were analyzed. The mean age was 62±15 years. The majority of the study population was male (66.7%) and predominantly African American (60.0%). Medicare (49.4%) and Medicaid (37.9%) were the predominant insurances. The geographic distribution of in-hospital admissions is illustrated in **Figure 1**.

The most common medical comorbidities included hypertension (HTN) (73.6%), type 2 diabetes mellitus (DM II) (43.7%), heart failure with reduced ejection fraction (HFrEF) (29.9%), chronic kidney disease (CKD) (24.1%), coronary artery disease (CAD) (18.4%), chronic pulmonary disease (19.4%), atrial fibrillation (AF) (18.4%), and cerebrovascular disease (CVD) (10.8%).

*Clinical characteristics*

The following means were observed: BMI 44.85±25.68 kg/m$^2$, systolic blood pressure 109.97±25.68 mmHg, diastolic blood pressure 68.19±52.20 mmHg, pulse rate 88.74±26.29 beats/minute, temperature 93.11±8.63 degrees F, serum lactate 4.46±4.15 mmoles/L, hemoglobin 11.16±2.56 mg/dl, serum creatinine 2.21±2.01 mg/dl and platelet count 209.92±91.61 k/uL. Commonly used prior medications used by the study population included beta-blockers (26.9%), loop diuretics (17.2%) and aspirin (16.1%). In this study population 42/87 patients (48.28%) had a prior history of cardiac arrest. Most of the patients presented with stage C cardiogenic shock (28.74%). 30.0% had an underlying valvular disease or arrhythmia leading to cardiogenic shock. Other causative pathologies included biventricular failure (24.1%) and left ventricular failure (12.64%). The majority of patients (62.06%) had denovo acute heart failure resulting in their presentation.

*Clinical characteristics of patients being discharged to home and healthcare facilities compared to patients being discharged to hospice and in-hospital mortality*

Patients who either died or were discharged to hospice were older on average (64.17 years)

**Table 1.** Characteristics at admission in patients being discharged to home and healthcare facilities compared to patients being discharged to hospice and in-hospital mortality

| Variables | In-hospital Mortality or Discharge to Hospice | Discharge to Home or Other Health Care Facilities | *p*-value |
|---|---|---|---|
| Gender | | | 0.25 |
| Male | 35 | 23 | |
| Female | 22 | 7 | |
| Age (Mean ± SD) | 64.17±3.47 | 57.73±15.99 | 0.002 |
| Insurance | | | 0.06 |
| Medicare | 21 | 6 | |
| Medicaid | 6 | 5 | |
| Medicare and Private | 12 | 4 | |
| Medicaid and Private | 11 | 11 | |
| Private | 3 | 2 | |
| Self-Pay | 2 | 4 | |
| Mode of Arrival | | | 0.52 |
| Home | 47 | 29 | |
| Clinic | 7 | 3 | |
| Skilled Nursing Facility | 1 | 0 | |
| Comorbidities | | | |
| Atherosclerotic vascular disease | 0 | 1 | 0.35 |
| History of CVA | 8 | 1 | 0.09 |
| History of CAD | 11 | 5 | 0.59 |
| Peripheral Arterial Disease | 2 | 1 | 0.04 |
| Prior CABG | 3 | 1 | 0.61 |
| Prior MI | 1 | 2 | 0.55 |
| Prior PCI | 1 | 2 | 0.52 |
| Atrial fibrillation or flutter | 13 | 3 | 0.10 |
| Chronic Kidney Disease | 12 | 9 | 0.60 |
| Chronic hemodialysis | 6 | 1 | 0.40 |
| Chronic liver disease | 2 | 1 | 0.60 |
| Chronic pulmonary disease | 11 | 6 | 0.11 |
| Diabetes Mellitus | 23 | 15 | 0.52 |
| Respiratory Infections | 2 | 0 | 0.55 |
| Heart Failure - Reduced EF | 14 | 12 | 0.23 |
| Ischemic Cardiomyopathy | 1 | 0 | 0.41 |
| Non-ischemic Cardiomyopathy | 2 | 3 | 0.34 |
| Presence of ICD | 1 | 2 | 0.54 |
| Presence of CRT | 2 | 0 | 0.52 |
| Heart Failure - Preserved EF | 12 | 2 | 0.13 |
| Hypertension | 42 | 22 | 0.65 |
| Hypertrophic cardiomyopathy | 6 | 4 | 0.17 |
| Smoking/Vaping | 0 | 2 | 0.12 |
| Valvular heart disease | 4 | 4 | 0.46 |

CVA-Cerebrovascular disease, CAD-Coronary Artery Disease, CABG-Coronary By-pass Graft, MI-Myocardial Infarction, PCI-Percutaneous Interventions, EF-Ejection Fraction, ICD-Implantable cardioverter - defibrillator, CRT-Biventricular pacemaker.

compared to those discharged to home or other healthcare facilities (57.73 years), with this difference being statistically significant (P < 0.05), as shown in **Table 1**. Older patients were more likely to be in the group experiencing poor outcomes, with this association being statistically significant (P < 0.05). Conditions such as serious mental disabilities and comatose presentations were also significantly more prevalent among those with poor outcomes (P < 0.05, as detailed in **Table 2**). Factors like elevated lactate levels, a history of prior cardiac arrest, and denovo heart failure were notably linked to higher mortality or discharge to hospice care (P < 0.05). Conversely, undergoing cardiac procedures was more common among patients who were discharged to their homes or transferred to other healthcare facilities (P < 0.05).

**Table 3** illustrates the findings of logistic regression analysis.

Most of the causes of cardiogenic shock were non-AMI related (92%) (**Figure 2**). Among the non-AMI related causes, most common etiology was heart failure (52.87%) and arrhythmia (30.0%) followed by cardiomyopathy (3.4%), pericardial effusion (2.3%), and valvular heart disease (1.1%). Pericardiocentesis was performed for both cases with effusion (100%). All of the cases with valvular heart disease were managed medically using diuresis. In cases of cardiomyopathy, diuresis was the initial treatment, with 66.7% of patients subsequently undergoing ischemia evaluation; unfortunately, one patient died

**Table 2.** Association of clinical parameters with discharge disposition

| Clinical Characteristics | In-hospital Mortality or Discharge to Hospice | Discharge to Home or Other Health Care Facilities | *p*-value |
|---|---|---|---|
| Height on admission in cm | 160.26 | 170.59 | 0.42 |
| Weight on admission in lbs | 39.96 | 38.15 | 0.42 |
| BMI (kg/m$^2$) | 40.49 | 42.36 | 0.20 |
| SBP on admission | 109.69 | 110.67 | 0.82 |
| DBP on admission | 66.28 | 71.94 | 0.55 |
| HR on admission | 87.7 | 90.9 | 0.69 |
| Temperature on admission | 90.97 | 97.37 | 0.28 |
| Lactate on admission | 5.27 | 3.09 | 0.002 |
| Hemoglobin on admission | 10.73 | 12.02 | 0.24 |
| Creatinine on admission | 5.18 | 3.09 | 0.28 |
| Platelet count on admission | 206.79 | 216.24 | 0.94 |
| Neurological status at admission | | | |
| Conscious without disability | 17 | 22 | 0.31 |
| Conscious with disability | 16 | 2 | 0.001 |
| Comatose | 17 | 7 | 0.03 |
| Sedated | 5 | 1 | 0.18 |
| Shock onset | | | |
| On arrival | 26 | 15 | 0.07 |
| In-hospital | 31 | 18 | 0.03 |
| SCAI class on admission | | | |
| C | 13 | 12 | 0.68 |
| D | 13 | 8 | 0.28 |
| E | 13 | 4 | 0.001 |
| Prior Cardiac Arrest | 29 | 13 | < 0.001 |
| Shock Pathophysiology | | | |
| Biventricular Failure | 14 | 7 | 0.09 |
| Left Ventricular Failure | 6 | 5 | 0.76 |
| Primary other Cardiac (Arrhythmia, Valvular stenosis, etc.) | 14 | 12 | 0.21 |
| Right Ventricular Failure | 1 | 0 | 0.06 |
| Category of Shock | | | |
| Acute-on-chronic HF | 15 | 10 | 0.32 |
| Acute, de novo HF | 37 | 17 | 0.001 |
| Medication Use at the onset of shock | | | |
| IV heparin | 1 | 2 | 0.17 |
| Dobutamine | 9 | 9 | 0.63 |
| Dopamine | 4 | 1 | 0.51 |
| Epinephrine | 25 | 11 | 0.21 |
| Norepinephrine | 34 | 14 | 0.75 |
| Phenylephrine | 7 | 3 | 0.17 |
| Vasopressin | 7 | 4 | 0.63 |
| Cardiac Procedures Done | 1 | 6 | 0.004 |
| ICU Days | 7.30 | 7.39 | 0.95 |

BMI-Body Mass Index, SBP-Systolic Blood Pressure, DBP-Diastolic Blood Pressure, HR-Heart Rate, SCAI-Society for Cardiovascular Angiography & Interventions, HF-Heart Failure, IV-Intravenous, ICU-Intensive Care Unit.

**Table 3.** Logistic regression

| Variable | OR [95% CI] | *p*-value |
|---|---|---|
| Older age | 3.39 (3.33-3.45) | < 0.05 |
| Male gender | 0.45 (0.10-0.81) | 0.64 |
| More than 1 pressor | 3.39 (2.62-4.15) | < 0.05 |
| High BMI | 1.82 (1.75-1.88) | 0.06 |
| Heart Rate | -0.53 (-0.55-(-0.52)) | 0.59 |
| MAP | 1.83 (1.75-1.92) | 0.06 |
| Increasing lactate levels | 0.27 (0.07-0.48) | 0.78 |
| Worsening ALT | 1.28 (1.20-1.21) | 0.22 |
| High SCAI class | 2.10 (1.51-2.70) | 0.03 |

MAP-Mean Arterial Pressure, ALT-Alanine Transaminase, SCAI-Society for Cardiovascular Angiography & Interventions.

upon admission. The primary management strategies for heart failure included vasopressor support (52.2%), intravenous diuresis (32.6%), and dobutamine for inotropic support (21.7%). Advanced heart failure therapies were considered for two patients. Arrhythmias were treated using defibrillation (38.5%) and cardioversion (19.2%), with rate control (19.2%) and rhythm control (11.5%) strategies also applied. Some arrhythmia cases were resolved with only pressor support (15.4%), and pacing was necessary in two instances.

Older age (RR=3.4 [95% CI: 3.3-3.45]), use of more than 1 pressor (RR=3.4 [95% CI: 2.6-4.2]), and higher SCAI class (2.1 [95% CI: 1.5-2.1], all P < 0.05) were independent predictors of mortality in patients with cardiogenic shock.

*Clinical characteristics of African American patients compared to other races*

African American patients, when compared to others, were found to have lower hemoglobin levels upon admission, presenting with higher rates of anemia (11.12±2.79 vs. 12.18±2.54 mg/dl; P=0.04). They were more frequently treated with phenylephrine (P < 0.05) and had a higher likelihood of needing intensive care unit (ICU) services (P=0.007). Additionally, their hospital stays were longer on average (8.50±7.30 vs. 5.19±4.80 days; P=0.04).

## Discussion

Before the 1960s, patients with acute myocardial infarction (AMI) were treated in general medicine wards, resulting in high mortality rates [18]. The first Coronary Care Unit (CCU) was established in Kansas City, Missouri, focusing on superior care for AMI patients with measures like patient grouping, immediate CPR/defibrillation, and arrhythmia monitoring [18]. This led to a significant decrease in AMI mortality rates to 15.9%. Despite advancements, ventricular fibrillation and arrhythmias persisted, prompting the development of reperfusion therapies [19]. Mortality further improved with revascularization therapies and the use of telemetry units for post-MI monitoring [20, 21]. Strict adherence to door-to-balloon time has kept mortality rates relatively low [22]. However, the incidence of cardiogenic shock increased from 2003 to 2010, and the prevalence of heart failure is expected to rise [23, 24]. Increased screening by multidisciplinary teams has helped identify high-risk cohorts. However, these trends have not been widely observed in Black or Hispanic populations with non-AMI cardiogenic shock [25]. The study noted a common pattern where delays in diagnosing cardiogenic shock led to postponed transfers to the Critical Care Unit (CCU). This delay often resulted in the clinical condition of patients worsening, subsequently reducing the likelihood of them being considered for invasive hemodynamic assessments.

There were a few key findings of our study. The mean age of the patients was 62±15 years, and most were male (66.7%). Additionally, older age was an independent predictor of inpatient mortality (P < 0.05). Previous studies have documented the importance of age and gender in long-term survival associated with cardiogenic shock and non-AMI cardiogenic shock. Our study's mean age of patients was relatively similar to a study conducted in 2021 [26-28]. The age group was also similar to patients studied for non-AMI cardiogenic shock [29]. The 30-day survival rate was lower for older age groups compared to younger ones, irrespective of their SCAI classification [26]. In our study, older patients were also observed to be discharged to hospice care. Older age has been identified as the most critical factor in determining mortality and discharge disposition after SCAI classification [30]. Several aging factors could lead to poorer results in elderly patients [31]. These include frailty, unconventional or delayed clinical symptoms, multiple concurrent diseases, hindered organ functionality, altered medication metabolism, diminished physiological re-

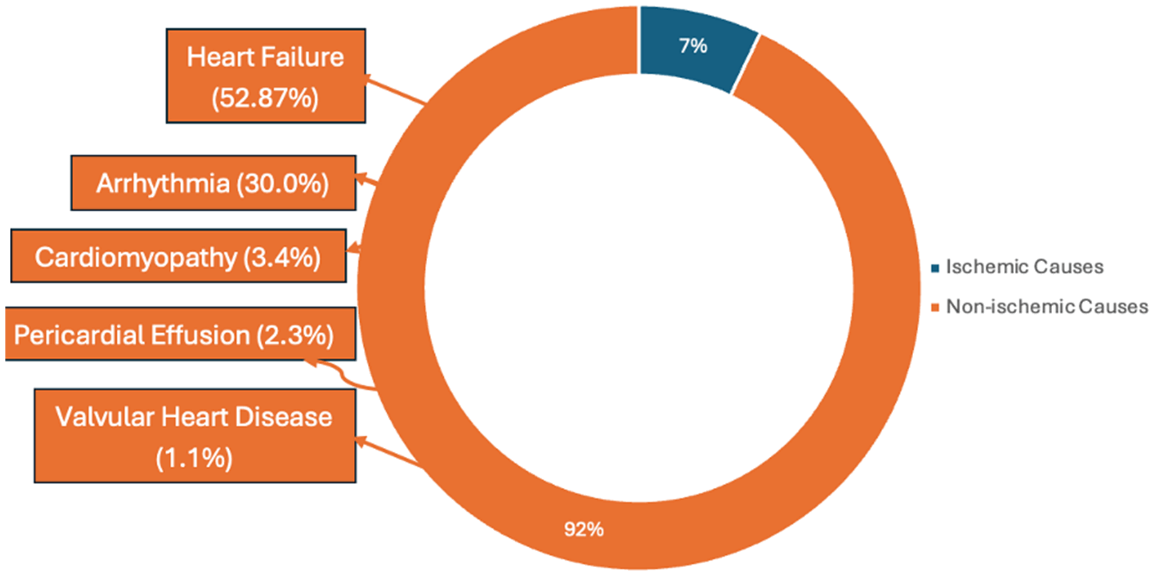


**Figure 2.** Causes of cardiogenic shock.

serve, and irregular cardiovascular physiology [31]. With respect to non-AMI cardiogenic shock, male gender in addition to older age has also been identified as one of risk factors for inpatient mortality and higher re-admission rates [29]. However, male gender was not found to be a significant factor in our study. Additionally, with respect to African American patients, older age and male gender were not significant risk factors observed in our study, primarily as the study cohort had more causes leading to non-AMI cardiogenic shock.

Most patients had either Medicare (49.4%) or Medicaid (37.9%) insurance. While this type of insurance has been observed as a risk factor for inpatient mortality in AMI-cardiogenic shock, most of our patients had non-AMI related cardiogenic shock [32]. It can be hypothesized that insurance had an impact on therapies for curing diseases responsible for non-AMI cardiogenic shock including heart failure and arrhythmias. Individuals with Medicaid were found to have lower rates of ablation for atrial fibrillation when compared to individuals with private insurances [33]. Similar trends were observed for implantation of left ventricular assist device [34]. Additionally, the wait-list time for definitive therapy, for example, heart transplant was comparatively much longer [35].

The study identified common medical comorbidities among patients with cardiogenic shock, including HTN (73.6%), type 2 DM (43.7%), HFrEF (29.9%), CKD (24.1%), CAD (18.4%), chronic pulmonary disease (19.4%), AF (18.4%), and CVD (10.8%). Acute kidney injury was prevalent, indicated by a mean creatinine level of 2.21±2.01 mg/dl. Patients with acute kidney injury were typically older, male, and had higher rates of diabetes and heart failure, along with more instances of chronic kidney disease, non-ST-segment-elevation AMI-CS, organ failure, cardiac arrest, and invasive procedures [36]. While the association between kidney failure and heart failure-related cardiogenic shock was hypothesized, particularly in cases involving right ventricular or biventricular pathologies, these risk factors have not been extensively studied in non-AMI cardiogenic shock [37]. Cardiorenal syndromes involve a mix of hemodynamic and non-hemodynamic factors, including reduced renal perfusion due to heart pump failure leading to prerenal acute kidney injury, and right ventricular failure causing renal venous congestion [37]. The balance of neurohormonal systems activated in response to heart function reduction can have both beneficial and harmful effects, such as peripheral vasoconstriction and sodium-water retention, which can increase cardiac afterload [37].

Obesity was also prevalent in the study population (mean BMI: 44.85±25.68 kg/m$^2$) and is known to be associated with adverse outcomes

[38, 39]. While the 'obesity paradox' is observed in heart failure, with higher rehospitalization rates among obese individuals, moderate or severe obesity is linked to significantly increased mortality in cardiogenic shock (CS) [40, 41]. Severely obese individuals may experience poorer outcomes due to more severe comorbidities, such as significant deconditioning [42]. Managing obese patients requiring mechanical circulatory support (MCS) is more complex and can lead to higher rates of procedural complications [42]. Obesity, particularly in classes II and III, is a contraindication for advanced heart failure therapies, potentially limiting the success rate of bridging to such therapies and explaining why class III obese patients are less likely to receive heart transplants [42].

The majority of the patients in our study were also anemic (Mean hemoglobin level: 11.16± 2.56 mg/dl). The presence of anemia, without concurrent iron deficiency, in patients presenting with CS at hospital admission is associated with a high all-cause inpatient mortality as well as the need for renal replacement therapy in a recent study [43]. Anemia can significantly exacerbate the condition of patients with CS, as both disorders lead to increased oxidative stress, inflammation, and sympathetic activity [44, 45]. Lower hemoglobin levels in anemic patients can further impair myocardial function, potentially causing ventricular pump failure [46]. CS patients, meanwhile, are unable to increase their cardiac stroke volume to avoid hypoxia [46].

42/87 patients (48.28%) had a history of cardiac arrest prior to the initiation of the retrospective study. 24/42 (57.14%) had an out-of-hospital cardiac arrest. None of the patients had defibrillators for secondary prevention. Mostly non-African American patients had a history of cardiac arrest (60%). Most of the patients with a history of cardiac arrest had Medicare (60%). Most of the patients presented with stage C cardiogenic shock as per SCAI classification (28.74%). History of prior cardiac arrest was significantly associated with the cohort for patients leading to mortality or hospice ($P < 0.05$). Higher SCAI class was an independent predictor of mortality in patients with CS as observed in a prior study focused on predictors of inpatient mortality with CS [26].

The majority of the patients had underlying valvular disease or arrhythmia leading to cardiogenic shock (30.0%). Other causative pathologies included biventricular failure (24.1%) and left ventricular failure (12.64%). The majority of the patients had denovo acute heart failure resulting in cardiogenic shock (62.06%). This is a particularly interesting finding, considering AMI is the most commonly documented etiology for CS [26]. In our population, cardiomyopathies followed by arrhythmias were more prevalent. In one study conducted in 2021, recent onset supraventricular arrhythmia was one of the causes of non-ischemic CS and likely reversible after ablation [47]. In these causes, earlier interventions as well as compliance are needed to ensure a reduction in mortality rates that are a few challenges faced by the South Bronx population.

With respect to race, African American patients were more likely to be admitted to ICU with a longer length of stay. Longer length of stay has been documented earlier in other studies which included minorities [48-50]. A few factors responsible for these findings have been discussed including lower socioeconomic strata, medication noncompliance, and subjective treatment preferences that can result in delayed presentation and complications needing ICU level of care [48]. The NIS data estimates have shown a lower prevalence of cardiogenic shock in recent years (from 6 to 7%) and a higher prevalence in Caucasians (77 to 79%) [23]. Additionally, most of the patients in NIS estimates had Medicare insurance [23]. While mechanical support devices were extensively used in NIS data, however, right heart catheterization was less common [23]. In comparison, our study population was predominantly African American, had Medicare or Medicaid insurance and an underutilization of mechanical support devices and right heart catheterization was also observed. A few reasons for this disparity are possible including a delay in follow-up and compliance and triaging based on algorithms. One of the major causes of non-AMI-CS is heart failure. Conventional cardiovascular risk factors such as hypertension, diabetes, obesity, and chronic kidney disease are recognized contributors to the onset of heart failure [51]. Among African Americans, these risk factors are significantly more prevalent compared to other racial and ethnic groups, apart from diabetes, which is marginally more common among Hispanics [51]. African Americans face a nearly threefold increased risk of developing dilated cardiomyopathy and a twofold increased risk of death post-diagnosis, unaffected by socioeconomic status and hypertension [51]. Recent genetic research in an African American cohort estimated dilated cardiomyopathy heritability at 33%, identifying a novel locus in the CACNB4 gene and four unique BAG3 variants linked to higher mortality or heart failure hospitalization risks [51].

The legacy of economic and racial segregation, particularly due to redlining practices from the 1930s to the 1970s, has resulted in persistent economic inequalities that still impact cardiovascular health today [51]. Studies have shown that individuals in economically deprived and racially segregated neighborhoods have a higher risk of developing cardiovascular diseases and heart failure even after accounting for traditional risk factors, ultimately resulting in cardiogenic shock [51]. Neighborhood factors such as limited access to physical activity facilities, low walkability, and scarcity of healthy food options contribute to poor cardiovascular outcomes. Implicit bias in healthcare also exacerbates these disparities, as African Americans with HF receive less aggressive treatment and fewer referrals to specialists [51]. Despite guidelines and novel therapies, adherence and utilization remain suboptimal, partly due to skepticism about race-based medical recommendations and financial barriers. Moreover, African Americans are underrepresented in clinical trials, limiting the generalizability of research findings to this high-risk population. Addressing these challenges requires targeted prevention, improved adherence to treatment guidelines, broader genetic testing, and ensuring equitable access to advanced therapies and clinical trials for African Americans [51].

Our study faces several limitations. It is retrospective and includes a disproportionate number of male participants, despite attempts to adjust for this imbalance. The focus on a small patient group is due to zip code distribution limits and the post-COVID era context of the hospital. A significant challenge in the South Bronx healthcare system is ensuring patients consistently follow healthcare strategies and attend follow-up appointments. Additionally, financial constraints, delayed care, and non-adherence to medication lead patients to present in critical condition at the emergency department. Consequently, by the time they are admitted to intensive care, their condition often worsens, hindering further diagnostic efforts and potentially overlooking the specific characteristics of their cardiogenic shock. Further studies are needed to focus on post-discharge data, such as mortality, readmissions, and long-term recovery, which are essential for a comprehensive understanding of the patient journey and improving continuity of care.

## Conclusion

The study highlights the significant burden of cardiogenic shock on healthcare facilities, particularly in a high-risk, underprivileged population characterized by a high prevalence of African American and Hispanic patients. The findings underscore older age, the use of multiple pressors, and higher SCAI class as independent predictors of inpatient mortality among patients with cardiogenic shock. Additionally, the study brings to light the challenges faced by this population, including financial limitations and disparities in healthcare access and delivery, which are further exacerbated by a higher likelihood of non-AMI cardiogenic shock presentations. The data suggests a pressing need for targeted interventions aimed at improving the survival rates of cardiogenic shock patients in such communities. These interventions could include enhancing early diagnosis and referral processes, increasing the utilization of mechanical support devices and right heart catheterization, and addressing the broader socioeconomic and healthcare access issues that contribute to delayed presentation and complications. Furthermore, the study's findings advocate for the importance of personalized healthcare strategies that consider the demographic and socioeconomic context of the patient population. Cardiogenic shock remains a critical challenge for healthcare providers, particularly in underserved communities like the South Bronx. The study's insights into the predictors of mortality and the barriers to effective treatment provide a valuable foundation for developing strategies to improve outcomes for cardiogenic shock patients. Future research should focus on implementing and evaluating interventions that address the identified disparities and challenges, with the ultimate goal of reducing mortality rates and improving the quality of care for all patients with cardiogenic shock. Additionally, further efforts should also focus on comparing different treatment modalities, such as mechanical circulatory support devices, to identify the most effective interventions. Furthermore, transitioning from observational data to interventional studies or randomized controlled trials within the South Bronx community could provide actionable insights into effective strategies for managing cardiogenic shock, ultimately improving patient outcomes.

### Acknowledgements

We acknowledge the kind efforts and valuable comments of Dr. Triston B.B.J. Smith that helped improve our manuscript.

### Disclosure of conflict of interest

None.

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